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Claims

1. A method of producing curved cuts (9) in a transparent material, in particular in the cornea (5), by generating optical breakthroughs (8) in the material (5) by means of laser radiation (3) focused into the material (5), wherein the focal point (7) is three-dimensionally shifted in order to produce the cut (9) by a series of optical breakthroughs (8), and wherein the shifting of the focal point (7) can be effected at a maximum speed which is lower in a first spatial direction (z) than in two other spatial directions, **characterized in that** the focal point (7) is guided such that it follows, with respect to the two other spatial directions (x, y), contour lines (17) of the cut (9), which contour lines are located in planes that are substantially perpendicular to the first spatial direction (z).
2. The method as claimed in Claim 1, characterized in that the contour lines are elliptical with an ellipticity of between 1.0 and 1.2.
3. The method as claimed in Claim 1 or 2, characterized in that the distances of the contour lines (17) in the first spatial direction are selected such that the average distances between adjacent contour lines (17) are substantially constant, especially within $\pm 10\%$.
4. The method as claimed in any one of the above Claims, characterized in that, for each contour line, the focal point (7) is moved completely along the contour lines (17) except for a residual portion, and a transition (18) to the next contour line (17) is effected in the residual portion by shifting the focal point (7) in the first spatial direction (z).
5. The method as claimed in any one of the above Claims, characterized in that, for higher orders of curvature of the cut (9) the contour lines (17) are obtained by sectioning a curved cut surface (9), which is corrected with regard to higher orders of curvature, with planes perpendicular to the first spatial direction (z).



6. The method as claimed in Claim 5, characterized in that the shift in the first spatial direction (z) is modified according to the influence of the higher orders of curvature, while the focal point (7) is being shifted in the two other spatial directions (x, y) according to the contour lines (17) which are assigned to the corrected cut surface (9) without higher orders of curvature.

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7. The method as claimed in any one of the above Claims, characterized in that a contact glass (21) is placed onto the material, said contact glass (21) imparting a particular shape (22) to the material, wherein said shape is considered for the contour lines.

10 8. The method as claimed in any one of the above Claims, characterized in that the laser radiation (3) is deactivated with respect to generating optical breakthroughs (8), as long as the contour line (17) extends outside a desired region of the material (5) in which the cut (9) is to be produced, said desired region (19) being, in particular, circular as viewed along the first spatial direction (z).

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9. An apparatus for producing curved cuts (9) in a transparent material, in particular in the cornea (5), said apparatus comprising a laser radiation source (S) which focuses laser radiation (3) into the material (5) and causes optical breakthroughs (8) therein, wherein a scanning unit (6, 10) which three-dimensionally shifts the focal point (7) and a control unit (2) which controls the scanning unit (6, 10) are provided, in order to form the cut surface (9) by sequential arrangement of the optical breakthroughs (8) in the material (5), and wherein the scanning unit (6, 10) comprises adjustable optics (6) for shifting the focal point (7) in one spatial direction (z), **characterized in that** the control unit (2) controls the scanning unit (6, 10) such that the focal point (7) is guided in two other spatial directions (x, y) on contour lines (17) of the cut (9), which contour lines are located in planes that are substantially perpendicular to the first spatial direction (z).

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10. The apparatus as claimed in Claim 9, characterized in that the adjustable optics comprise a telescope arrangement (6).

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11. The apparatus as claimed in any one of the above apparatus claims, characterized in that the scanning unit (6, 10) comprises two tilting mirrors (11, 12) with crossed axes of rotation in order to effect the focus shift in the two other spatial directions (x, y).

35 12. The apparatus as claimed in Claim 9 or 10, characterized in that the contour lines are elliptical with an ellipticity of between 1.0 and 1.2.



13. The apparatus as claimed in any one of the above apparatus claims, characterized in that the control unit (2) selects the distances of the contour lines (17) in the first spatial direction such that the average distances between adjacent contour lines (17) are substantially constant, especially within $\pm 10\%$.

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14. The apparatus as claimed in any one of the above apparatus claims, characterized in that, for each contour line, the control unit (2) moves the focal point (7) fully along the contour line (17) except for a residual portion, and effects a transition (18) to the next contour line (17) in the residual portion by shifting the focal point (7) in the first spatial direction (z).

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15. The apparatus as claimed in any one of the above apparatus claims, characterized in that, for higher orders of curvature of the cut (9), the control unit (2) determines the contour lines (17) by sectioning a curved cut surface (9), which is corrected with regard to higher orders of curvature, with planes perpendicular to the first spatial direction (z).

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16. The apparatus as claimed in Claim 15, characterized in that the shift in the first spatial direction (z) is modified according to the influence of the higher orders of curvature, while the focal point (7) is shifted in the two other spatial directions (x, y) according to the contour lines (17) which are assigned to the corrected cut surface (9) without higher orders of curvature.

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17. The apparatus as claimed in any one of the above apparatus claims, characterized in that a particular shape is imparted to the surface of the material (5) by means of a contact glass (21), and that the control unit (2) considers said particular shape in the contour lines.

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18. The apparatus as claimed in any one of the above apparatus claims, characterized in that the control unit (2) deactivates the laser radiation (3) with respect to generating optical breakthroughs (8), as long as the contour line (17) extends outside a desired region of the material (5) in which the cut (9) is to be produced, said desired region (19) being, in particular, circular as viewed along the first spatial direction (z).

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19. The apparatus as claimed in any one of the above apparatus claims, characterized by a unit for intermediate deactivation or attenuation of the laser beam (3).

